

ACCURON CARTRIDGE METER

MUNICIPAL AGENCY TEST RESULTS

U.S. BUREAU OF RECLAMATION ENVIRONMENTAL PROTECTION AGENCY U.S. DEPARTMENT OF AGRICULTURE

The high performance design of the Cartridge Meter is based upon information and recommendations obtained through extensive open channel metering field tests conducted by the U.S. Bureau of Reclamation, the Environmental Protection Agency and the U.S. Department of Agriculture. The Eastech Cartridge Meter is an economically acceptable, field reliable and maintenance-free open channel flowmeter satisfying the "under all conditions" operating requirements of the above mentioned government agencies.

THE FOLLOWING PAPERS CONTAIN CONDENSED TEST DATA SUMMERIZING THE CONCLUSIONS REACHED BY EACH RESPECTIVE AGENCY AS TO THE RELIABILITY OF THE ENGINEERED COMPONENTS UTILIZED IN THE DESIGN OF THE CARTRIDGE METER.



ACCURON CARTRIDGE METER

TRAPEZOIDAL FLUME MUNICIPAL AGENCY TEST RESULTS

U.S. ENVIRONMENTAL PROTECTION AGENCY,
U.S. BUREAU OF RECLAMATION AND
U.S. DEPARTMENT OF AGRICULTURE
TEST DATA ASSESSING THE VIABILITY OF TRAPEZOIDAL
FLUMES FOR OPEN CHANNEL FLOW MEASUREMENT.



EPA-600/2-75-027

SEWER FLOW MEASUREMENT: A STATE-OF-THE-ART ASSESSMENT

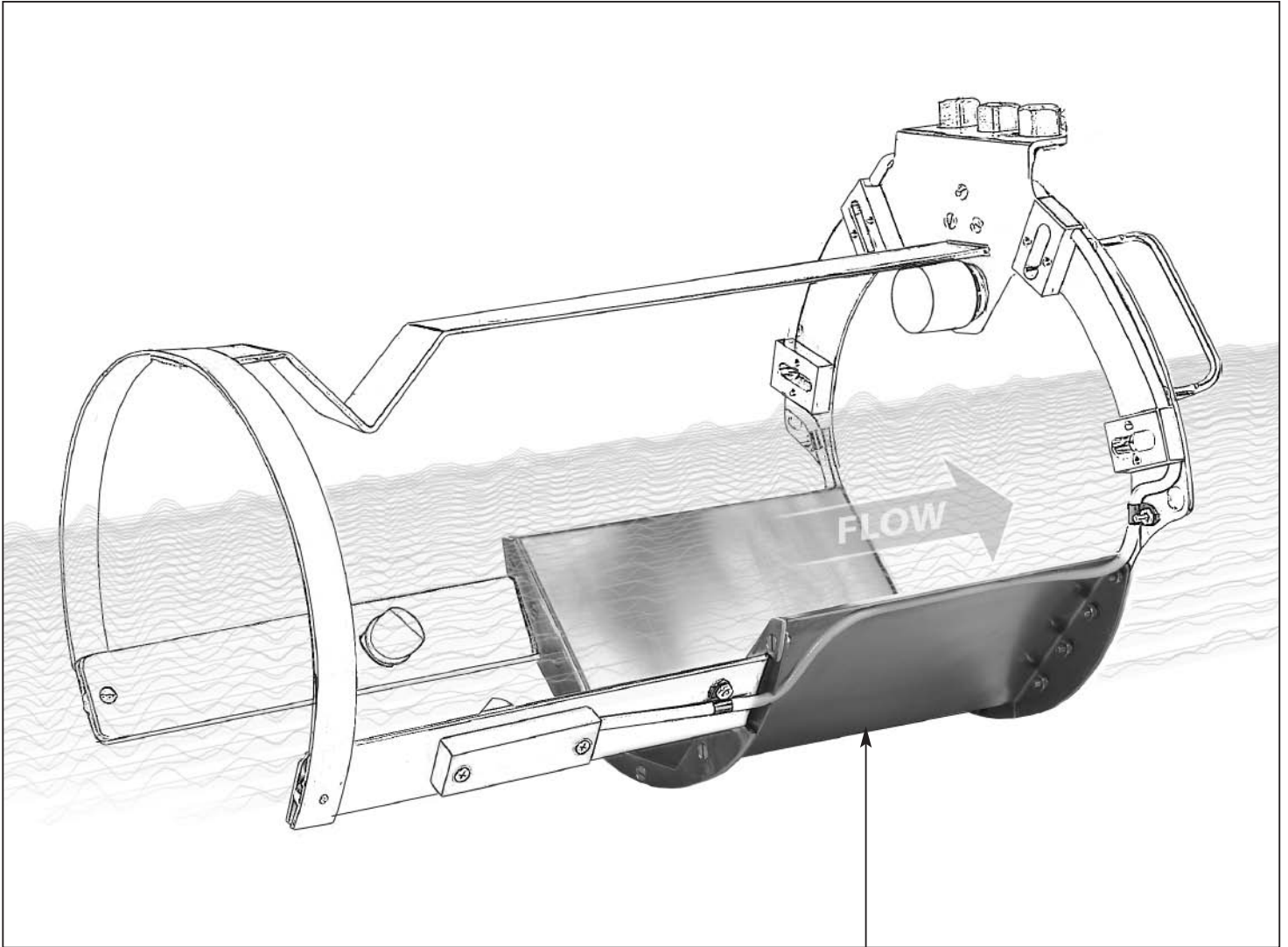


EPA/600/R-01/043

PERFORMING QUALITY FLOW MEASUREMENTS AT MINE SITES



BUREAU OF RECLAMATION
U.S. DEPARTMENT OF AGRICULTURE
WINFLUME SOFTWARE FOR FLOW MEASUREMENT VERSION 1.05.0027



TRAPEZOIDAL FLUME

**U.S. ENVIRONMENTAL PROTECTION AGENCY DOCUMENT EPA-600/2-75-027
SEWER FLOW MEASUREMENT: A STATE-OF-THE-ART ASSESSMENT**



PAGE 86: TRAPEZOIDAL FLUMES – In attempts to obtain wider ranges of discharge than those that can be obtained with Parshall or San Dimas flumes, several investigators have considered supercritical trapezoidal flumes. The outward sloping of the flume walls provides increased sensitivity to lower discharge rates for a given size and hence, increased range.

PAGE 91: TRAPEZOIDAL FLUME EVALUATION

EVALUATION PARAMETER	EVALUATION
RANGE	GOOD
FLOW EFFECTS ON ACCURACY	SLIGHT
SUBMERGENCE/BACKWATER EFFECT	LOW
EFFECT OF SOLIDS MOVEMENT	SLIGHT
FLOW OBSTRUCTION	SLIGHT
HEAD LOSS	LOW
INSTALLATION RESTRICTIONS	SLIGHT
SIMPLICITY & RELIABILITY	GOOD
UNATTENDED OPERATION	YES
MAINTENANCE REQUIREMENTS	LOW
RUGGEDNESS	GOOD
EASE OF CALIBRATION	GOOD
MAINTENANCE OF CALIBRATION	GOOD

**U.S. ENVIRONMENTAL PROTECTION AGENCY DOCUMENT EPA/600/R-01/043
PERFORMING QUALITY FLOW MEASUREMENTS AT MINE SITES**



PAGE 57: WATER MEASUREMENT DEVICE SELECTION CRITERIA

TRAPEZOIDAL FLUME – Can measure super-critical flows, the trapezoidal cross-section permits a wider measurement range than other flumes, and the flat bottom passes sediment and other debris.

**U.S. BUREAU OF RECLAMATION and U.S. DEPARTMENT OF AGRICULTURE
WINFLUME SOFTWARE FOR FLOW MEASUREMENT VERSION 1.05.0027
(DESIGN SOFTWARE UTILIZED FOR CARTRIDGE METER FLUME CONSTRUCTION)**



WinFlume is a Windows-based computer program used to design and calibrate flume and weir flow measurement structures. The software was developed through the cooperative efforts of the U.S. Bureau of Reclamation, the Agricultural Research Service (USDA), and the International Institute for Land Reclamation and Improvement. The WinFlume software allows for the design of trapezoidal flumes that meet unique operational site requirements while eliminating the need for laboratory calibrations.

ACCURON CARTRIDGE METER

ULTRASONIC LEVEL SENSOR

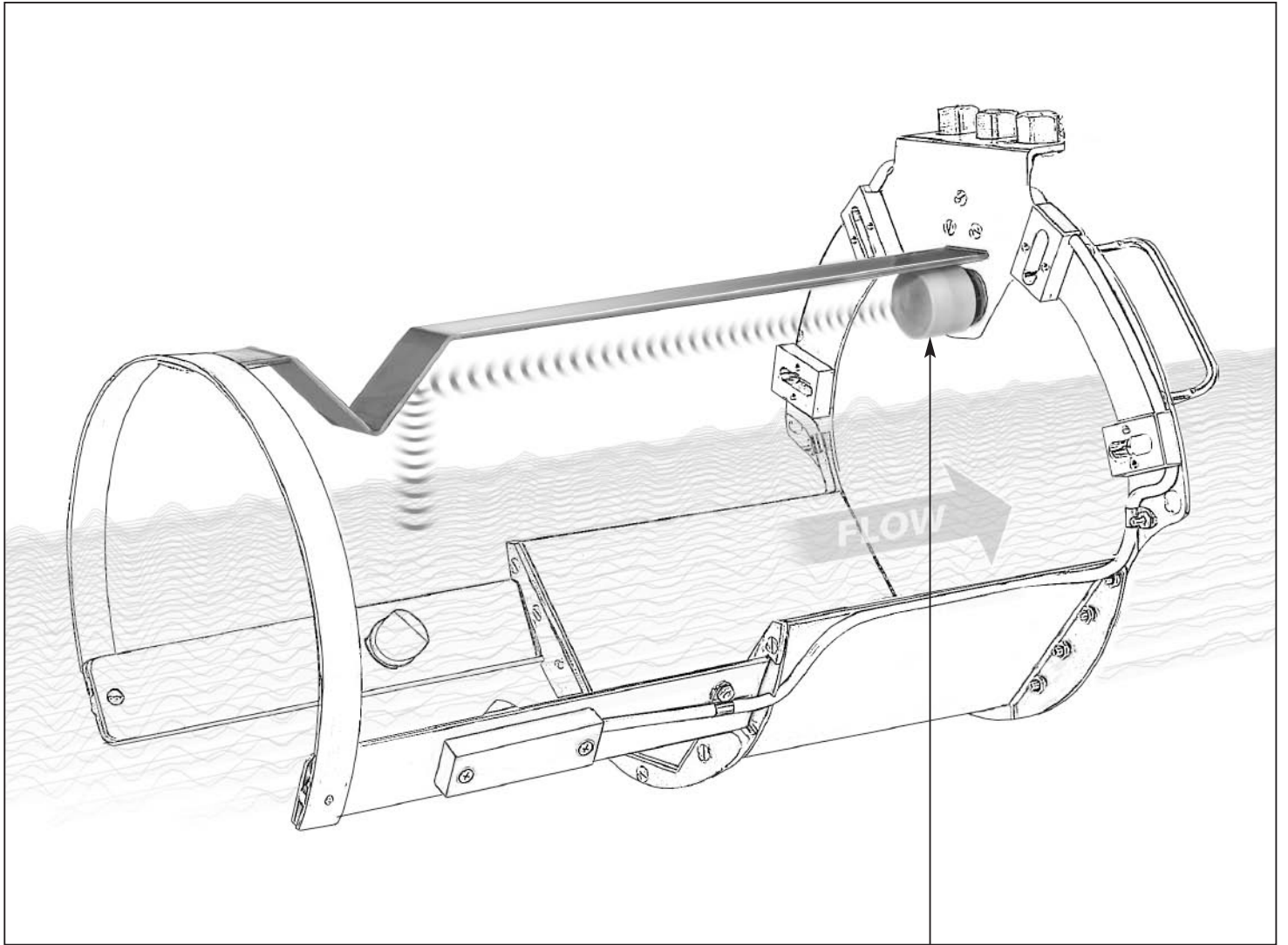
MUNICIPAL AGENCY TEST RESULTS

U.S. BUREAU OF RECLAMATION TEST DATA
ASSESSING THE VIABILITY OF VARIOUS LEVEL SENSORS
FOR OPEN CHANNEL FLOW MEASUREMENT.



ITRC R99-002

WATER LEVEL SENSOR AND DATALOGGER TESTING



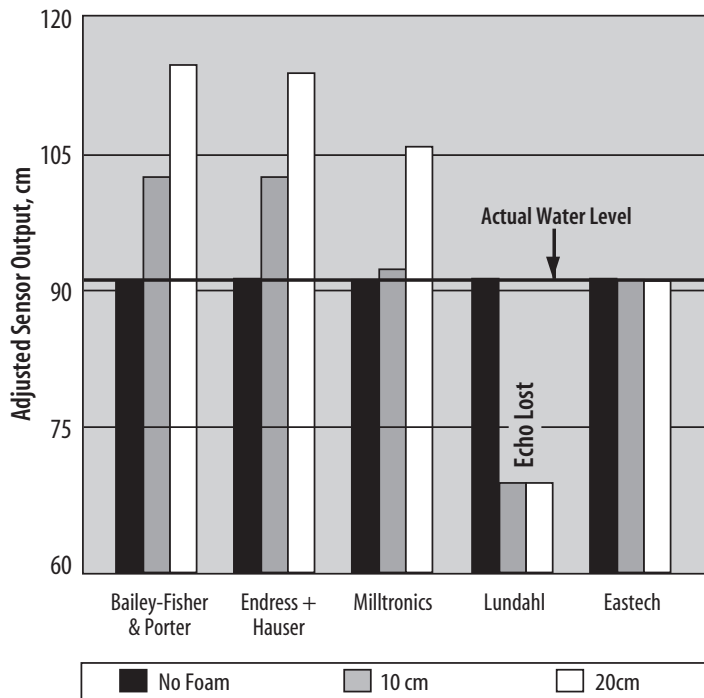
LEVEL SENSOR

**U.S. BUREAU OF RECLAMATION SPONSORED STUDY ITRC R99-002
5 YEAR WATER LEVEL SENSOR AND DATALOGGER STUDY**



PAGE 56/57: FOAM – Sound waves reflect off and are absorbed by any surface, so foam can easily alter an ultrasonic level reading. Foam tends to absorb the ultrasonic pulses and reflect them in many directions, which can result in a lost signal. Figure 35 shows ultrasonic sensor response to two depths of dish soap foam on a level water surface. The ability of an ultrasonic sensor to penetrate foam grows with decreasing beam angle and increasing strength of the sound pulses.

FIGURE 35. FOAM EFFECTS ON ULTRASONIC WATER LEVEL SENSORS



PAGE 61/62: TEST RESULTS – Of all the ultrasonic sensors tested, Eastech was the only one to successfully penetrate through dish soap foam. This is most likely due to this sensor’s relatively small beam angle and powerful signal. As did most of the ultrasonics, the Eastech 2500 displayed almost perfect linearity, hysteresis close to zero, and excellent long-term reliability.

ACCURACY TEST RESULTS

Cumulative Days	20	40	60	80	100	120	Overall
Average daily error during that 20-day period, ± % full scale	0.010	0.008	0.012	0.016	0.007	0.004	0.010

ACCURON CARTRIDGE METER

TRANSIT-TIME VELOCITY SENSORS

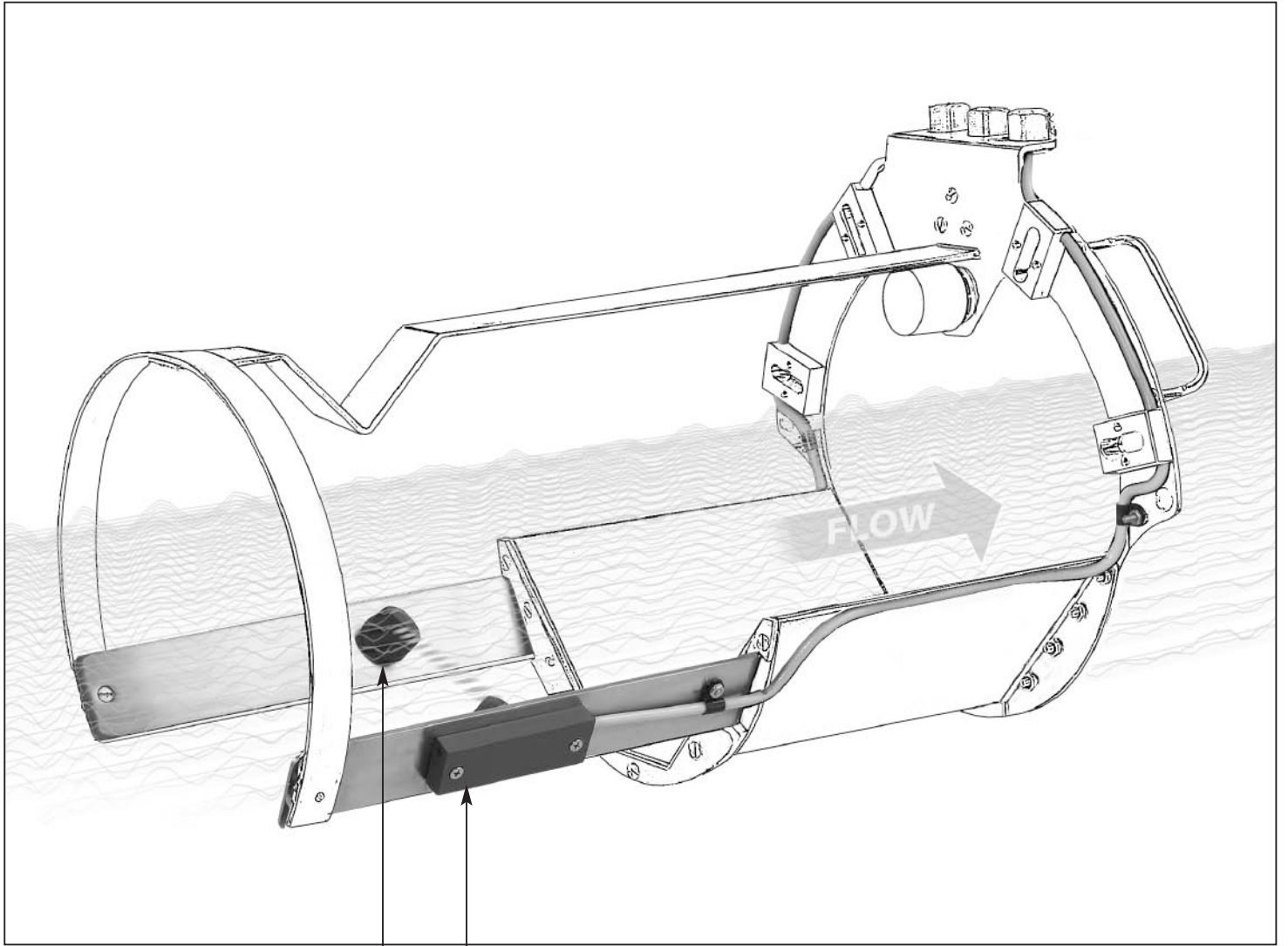
MUNICIPAL AGENCY TEST RESULTS

U.S. ENVIRONMENTAL PROTECTION AGENCY
TEST DATA ASSESSING THE VIABILITY OF
TRANSIT-TIME VELOCITY SENSORS
FOR WASTEWATER FLOW MEASUREMENT.



EPA-600/2-76-243

WASTEWATER FLOW MEASUREMENT IN SEWERS USING ULTRASOUND



TRANSIT-TIME VELOCITY SENSORS

U.S. ENVIRONMENTAL PROTECTION AGENCY DOCUMENT EPA-600/2-76-243
WASTEWATER FLOW MEASUREMENT IN SEWERS USING ULTRASOUND



[IN AN 18 MONTH TEST, IT WAS VERIFIED THAT THE TRANSIT-TIME VELOCITY SENSORS WERE NEVER SUSCEPTIBLE TO FOULING BY PASSING DEBRIS AND GREASE, AND THE METERS ONCE OPERATIONAL, REMAINED IN SERVICE WITHOUT FURTHER ATTENTION FOR THE DURATION OF THE TEST.]

PAGE 1: CONCLUSIONS

1. Ultrasonic velocity measurement equipment in conjunction with ultrasonic level measurement can be utilized for the measurement of sewage volume flow.
2. The equipment is sufficiently low in cost to achieve general use, can be conveniently installed in new or existing sewers, requires minimum maintenance, and is suited for long term operation in the sewer environment.
3. Installation does not require special constructions.
4. Between 25% of channel depth and surcharged conditions the correlation between the average chordal velocity and the average area velocity is sufficiently predictable to enable the average chordal velocity, level and area functions to be easily integrated electronically providing flow information accurate to within approximately 2%.
5. The system has an 80:1 turndown capability which well exceeded the flow ranges experienced.

PAGE 62: PROBE FOULING BY DEBRIS AND GREASE – One of the major design features of considerable conjecture before the installations were made was the possible susceptibility to fouling of the velocity probes by passing debris and grease. A major result of the program was the demonstration that this did not in fact occur, and the meters, once operational, remained in service without further attention at least for the duration of the demonstration (18 Months) and probably indefinitely.

PAGE 64: EQUIPMENT COSTS – The ultrasonic system continues to measure accurately when the sewer is surcharged, when weirs and flumes become inoperative.

PAGE 67: VELOCITY PROFILE ANALYSIS – Concurrently with the demonstration of the metering equipment, an investigation of velocity profiles was undertaken. By their judicious placement, a single set of velocity probes allows sufficiently accurate (1-2%) measurement of the average area velocity for a wide range of levels provided that turbulent flow conditions exist. THIS IS A RESULT OF THE RELATIVE CONSTANCY OF THE K-FACTOR OVER A WIDE RANGE OF DEPTHS. THIS K-FACTOR HAS A SLIGHT VARIATION, FROM 0.96 TO 0.98, AS THE CHANNEL LEVEL CHANGES FROM 30% TO COMPLETELY FULL.